DOCUMENT RESUME

ED 229 121 PS 013 476

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TITLE	The Use of Stopped-Action Video Replay to Heighten Theory Testing in Young Children Solving Balancing Tasks. Final Report.
INSTITUTION	Massachusetts Univ., Amherst. School of Education.
SPONS AGENCY	National Inst. of Education (ED), Washington, DC.
PUB DATE	Dec 82
GRANT	NIE-G-81-0095
NOTE	27p.
PUB TYPE	Reports - Research/Technical (143)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Age Differences; Comparative Analysis; *Comprehension; *Concept Formation; *Feedback; Performance Factors; Pretests Posttests; *Training Methods; Videotape Recordings; *Young Children
IDENTIFIERS	*Balance; *Rule Application

ABSTRACT

The effectiveness of instant video replay in improving young children's understanding of the physical laws of balancing blocks on a fulcrum was investigated. A total of 128 children from 4 to 8 years of age were randomly assigned to one of four treatment conditions. In the "Predict Block" condition, children viewed a video replay that stopped action immediately after a block reached the fulcrum. Following viewing, children were asked to say what the block would do when the videotape continued. In the "Predict Self" condition, children saw a frame with stopped action just prior to the placement of the block on the fulcrum and were subsequently asked to say where the block would be placed when the videotape continued. In the "Summarize Video" condition, children watched a replay of their attempt to balance a block without any stopped action and were asked to summarize that attempt. Children in the "No Video" group were asked to summarize a recent attempt at balancing without video replay. Children in the "Predict Self" condition, who began the training sessions with some notion of the need to search for a general rule (albeit often the wrong rule), evidenced the best posttest improvement. For children who began the training sessions with an ad hoc approach to each block, the video replay conditions were either no better than the "No Video" condition or actually debilitated performance in the "Predict Self" condition. (Author/MP)

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The Use of Stopped-Action Video Replay to Heighten Theory Testing in Young Children Solving Balancing Tasks

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FINAL REPORT

December, 1982

National Institute of Education
Grant NIE G-81-0095

Project Officer: Rodney Cocking

PS013476

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ABSTRACT

This study investigated the effectiveness of instant video replay to improve young children's understanding of the physical laws of balancing blocks on a fulcrum. A total of 128 children from 4 to 8 years old were given 14 different wooden blocks, some with hidden weights embedded, some glued into configurations that required the use of counterweight. In the Predict Block condition children viewed a video replay that stopped action immediately after the block reached the fulcrum and then were asked to say what the block will do when the video tape is continued. In the Predict Self condition the children saw a stopped action just prior to the placement of the block and were asked to say where they will place the block to be seen when the video tape is continued. In the Summarize Video condition children watched a replay of their attempt without any stopped action and they were asked to summarize that attempt. In the No Video group were asked to summarize a recent attempt with no video replay.

For those children who began the training sessions with some notion of the need to search for a general rule, albeit often the wrong rule, the Predict Self condition yielded the best posttest improvement. For children who began the training sessions with an ad hoc approach to each block, the video replay conditions were either no better than the No Video condition or it acutally debilitated performance in the Predict Self condition. These findings were interpreted in terms of Piaget's theory of reflective abstraction, suggesting that feedback improves understanding only if the child assimilates the video replay to the confirmation or refutation of a theory in action.

Introduction

Solving a problem can be quite different from understanding the solution. As Piaget (1976) stated, success is different from understanding, since understanding involves consciousness of a general principle. A child might be successful, for example, as hitting a target with a rock released from a sling, but be confused about where in its spin the sling is released. In this case, the "feedback" of the success does not in itself provide sufficient information about the general physics of the trajectory. The child needs to reflect on the experience, invent some plausible assumption and then perform the task again to test the assumption. Understanding develops when the child shifts from a success orientation to a theory testing orientation.

Even a false assumption can be beneficial, as was demonstrated by Karmiloff-Smith and Inhelder (1974). These researchers discovered that the children who made the most progress in constructing the relation between weight and balance temporarily held strongly to a wrong theory based on the visual symmetry of asymmetrically weighted blocks. This false theory caused children to be surprised at an unexpected success and then go on to construct a new theory that could account for these "exceptions."

If a student can be successful without understanding the principle that accounts for the success then we as teachers have missed a primary educational objective. Technology that facilitates the student's construction of unifying principles are certainly a premium in education. Video replay offers an obvious case of such technology. Through video replay a student can review his/her attempts to solve a problem and reflect on the reason behind these attempts. Yet a straight replay may not be enough to create the shift from a success orientation to a theory testing orientation. In the next section we will review some of the ways video tapes have been used educationally. We will make the point that video replay should work best when the student is first encouraged to venture a guess and then uses the replay to confirm or refute that guess. Yet video replay has almost never been used in this way, and thus its potential for facilitating intellectual development has been seriously underestimated.

Video Research

There have been two broad categories of video research. In the first category, called filmic presentation, the student watches an educational video tape but is never personally taped. In the second category, called self-monitoring, the camera is used to tape the student who later watches himself or herself.

Filmic presentation. At least three types of filmic presentation can be found in the research literature. The first subtype, called monitoring content, concerns the effectiveness of messages presented on video tapes. For example, can the child learn as much from watching a monitor as from other media such as people and books (Henderson, Swanson, & Zimmerman, 1975; Trullinger, 1976)? This type of research gives us little information about how children reflect on their own assumptions. A second subtype takes one step away from content itself and has children watch another person's problem solving strategies. This is called monitoring strategies. For example, Thomas (1974) had children view video tapes of children demonstrating good study habits and found these same habits were adopted by the viewers. Jovick (1976) found that viewing an adult model solve classification tasks was effective in teaching classification to the viewers only if accompanied by probing questions. Due to insufficient control groups it was not clear how much the video tape contributed independent of the questioning. Be that as it may, in both types of research the child's thoughts are directed to either content or strategies generated by someone other than the child. In non-video research, Kuhn and Ho (1981) found that children who reflected on their own guesses improved more than a yoked-control group asked to reflect on identical guesses provided by the teacher.

A second step away from content comes with a focus on modes of presenting information unique to video or at least film. Salomon (1979) has advocated strongly that filmic presentation is more than just a convenient logistical device to display the same information presented in other media, but that the medium itself teaches the viewer new ways of processing information, such as "zooming" in on critical features of a visual display. In zooming, the camera itself models the cognitive act of selective focusing. The model for the child is not a person on the monitor, but is the operating characteristics of the medium itself. These are studies in how children model the medium. Salomon presents evidence that children who have trouble focusing on critical features improve in skill if given sufficient exposure to video tapes that use camera zooms. Salomon's research, however, does not take advantage of the replay capabilities of video recorders, a capability of central concern for the research proposed herein. Nor is Salomon concerned with self reflection.

A study of Rovet (1976), also an example of using the operating characteristics of filmic media, had children watch an object on film rotate to a new position. Some children saw only the initial frames and were asked to predict how the object would look if the rotation continued. Children in this treatment showed the best performance on transfer tasks compared to children who only saw the first and last frame or even children who saw the entire rotation. In other words, the film that encouraged the children to make a guess worked best. A comparable study by Salomon (1979), in which children were shown only the initial and final position of an object, was not effective, again probably because the children had no need to make guesses in advance of seeing the final position. Neither study, however, used film to provoke self-reflection.

<u>Self-Monitoring</u>. All instances of this type of research present the child with his/her own image on the video monitor. Very little of this research, however, uses video replay as a means to confront the child with his/her problem solving strategies and none seems concerned with helping the child understand his/her successes. The research falls into four categories: 1) self-recognition, 2) motor skills, 3) interpersonal skills, and 4) concept development.

Of course the first question regarding self-monitoring concerns the age at which children know that the image on the monitor is indeed themselves. Amsterdam and Greenberg (1977) report that by 20 months infants recognize themselves on the monitor by showing signs of self-consciousness, and Bigelow (1975) finds that this recognition exists by 26 months even when the image is a replay.

Video replay has been used extensively to help athlete's improve motor skills, but the research in children is more sparse. Bunker, Shearer, and Hall (1976) let children from 4 to 8 years of age watch themselves try to flutter kick in a swimming pool and found this technique worked better than verbal feedback from an instructor. Miklich, Chida, and Danker-Brown (1977) found that self-help skills increased as a result of self-monitoring, but this study only dealt with rate increase rather than an increase in proficiency. Greelis (1974) reports that low I.Q. inpatients can not only recognize tapes of themselves but also use these tapes as guides for increasing self-help skills and prosocial behavior.

By far the greatest use of self-monitoring in children has been in the area of interpersonal skills. This comes largely from the wide use of video replay in adult counseling, particularly family counseling and confrontation therapy (Berger, 1978). Yet most of this research is more concerned with increasing the rate of prosocial behavior than it is concerned with the child's understanding of social concepts. Esveldt, Dawson, and Forness (1974) allowed 10 year old boys to view their own disruptive behavior and noticed that its frequency decreased. No information is presented about new understandings that generated the decrease in disruptive behavior. Similar comments can be made about a study of Goshko (1973) on 5th and 6th graders and a study by Dowrick and Raeburn (1977) on a hyperactive 4 year old boy.

Understanding the reasons for prosocial behavior takes a central focus in the filmic presentation research of Kohlberg (1970) and Selman (1976). Pre-designed dilemmas were presented on filmstrips and the children discuss solutions. This research does not involve self-monitoring, however, and is mentioned only as a good example of a filmic presentation that is concerned with the child's understanding of social concepts through cognitive conflict. One can speculate that had Kohlberg and Selman been able to use video replay of the student's own social dilemmas the training effects would have been even more powerful.

The importance of understanding as a prerequisite for success can be seen in a study by Astor (1977). She found that aggressive behavior in boys from 7 to 10 years of age decreased with self-monitoring only if accompanied by a structured discussion. The study did not address the question of how the children reacted to unexpected success, say instances where an old aggressive response seem to increase peer esteem.

There are studies using video replay to teach academic concepts, but they represent the minority, at least with children. Video replay has been used much more to teach teachers, i.e. micro-teaching (Allen, 1967), than to teach students to teach themselves. Robinson (1974) asked students to evaluate their own performance on reading and arithmetic as seen on video tapes. This treatment worked much better in improving achievement than control students who merely evaluated their remembered performance. Other studies show similar results but none are very precise about how video replay works. Certainly video replay presents the student with richer content to work with than does raw memory, but we have seen in Astor (1977) and other research that understanding requires more than an enriched memory for past performances. What is important are the interpretive schemes that the child uses to reflect on that past performance. The purpose of the research herein was to discover what types of video replay activate the appropriate interpretive schemes.

Rationale

The realization that meaningful learning occurs best when the child is testing a hunch or prediction caused Inhelder, Sinclair, and Bovet (1974) to teach without telling. They simply confronted the student with his/her own contradictory guesses regarding quantitative changes in sets of objects that were changed only in position. After the student made a series of vascilations between opposite conclusions regarding essentially the same event, the student often spontaneously constructed a new theory that synthesized all the instances,--a clear example of what Piaget (1977) means by "equilibration through compensation." At first the contradictions were denied, later they became troublesome exceptions, and still later they became mere instances of the new theory.

This training paradigm, called the Predict-Observe paradigm, was also used in the Karmiloff-Smith and Inhelder (1974) study with younger children. Children from 4 to 7 years old tried to balance symmetrically and asymmetrically weighted blocks on a fulcrum. The experimenters allowed the children to choose at will from an assortment of blocks and occasionally asked the children to think outloud as they worked. It became obvious to the observers that after a period of time these children developed definite expectations about what determines balance. Usually these expectations were seen more in a series of actions, such as trying all blocks at their geometric center, rather than in an explicitly stated unifying rule. Karmiloff-Smith and Inhelder (1974) have termed these action schemes "theories-in-action."

The question can be raised, how can we use modern technology to help these theories-in-action to emerge, or better yet, to become more explicit for the child? What would happen if children, given the Karmiloff-Smith and Inhelder tasks, had had the benefits of video replay? In the research planned herein children slightly younger and slightly older will be presented with video replay using the Predict-Observe paradigm to see if we can facilitate the child's shift from a success orientation to a theory testing orientation.

To measure this shift from success orientation to theory orientation we turn to the six developmentally ordered phases described by Karmiloff-Smith and Inhelder (1974). In phase one the youngest children (age 4) placed the block anywhere and pressed down hard if it started to fall. In phase two the children seemed to ignore the consequences of balance and explored the different ways that a given block could be placed on the fulcrum, but this was not a search for the best point of balance. In phase three all blocks were placed at their geometric center, even if proprioceptive cues of weight made this strategy "obviously" futile. The blocks that would not balance at their geometric center were designated "impossible." In a fourth phase the children began to notice that only certain blocks placed in their geometric center always fell, and fell to a particular side. Yet corrections of placement were not immediately made toward the center of gravity. Nor was the relevance of proprioception immediately sensed. In the fifth phase the children, about age 7, would make a brief test at the geometric center, and if the block fell, they would shift immediately to the center of gravity. These children, however, still held to their geometric center theory-in-action with blocks that were both visually symmetrical and symmetrically weighted. They had not yet generated a single theory that would give a common account to both their failures and their successes. This sixth phase, of having one theory for all cases instead of two ad hoc theories, was found only infrequently by Karmiloff-Smith and Inhelder (1974), but might be found in older children (9 years old) or with 7 year olds who have had the benefit of video replay to reflect on their own actions.

Granted that children need to reflect on their actions in order to construct a theory in action, yet as these ordinal phases indicate, children at different phases might need to reflect on different aspects of action. Children in either of the first two phases might profit more from video replay focused on the consequences of the blocks. Children who over-generalize a partially correct strategy might profit more from video-assisted reflection on the exact nature of how they place the blocks. By using the Predict-Observe paradigm, a video tape replay can be stopped at critical points to have the child "recall" either 1) what happened just after the placement now shown on the stop-action or 2) what placement did the child make just after he/she grasped the block now shown on the stop-action. After the child tries to recall, the tape is advanced for the child to observe. We hypothesize that the younger children will profit more from a reflection on the block's action, given their tendency to egocentrically form assumptions about the role of their own action (pushing hard will help). Older children will profit more from reflection on the placements that are either consistent or inconsistent with their dominant theory. Remember that it was the middle ability children who would claim that a block was "impossible" to balance. Unlike the younger children, these children do not over-evaluate the importance of their action, they in fact under-evaluate the possibility that a new action might work better and even ignore the proprioceptive cues that come from action.

These video replay techniques do not differ in the total amount of exposure to past actions, but do differ in the intepretive schemes provoked. Thus any treatment differences can not plausibly be accounted for in terms that make video replay purely an aid to memory. Further note that it would be mistaken to assume that a child who is attempting to recall segments of his own past action is just rotely recalling that past event. More likely than not this Predict and Observe use of video replay involves in large measure a reapplication of the same reasoning that the child applied in real time when handling the blocks. The power of the replay comes in the fact that the action can be stopped at critical points, something that the teacher has no control over, nor would want to control, as the child works in real time. In this sense video stop-action is an operation of the medium that, in Salomon's terms (Salomon, 1979) might be supplanted into mental operations. This supplantation would be evident in changes occuring in the subsequent attempts to balance the real blocks. In the context of these speculative remarks, it is interesting to note that the children just about to construct a new theory based on weight in the Karmiloff-Smith and Inhelder study shifted in their pattern of pauses. Instead of pausing immediately after a block balanced or fell, they would select a block, make an abbreviated move to place the block, and then pause in apparent thought before placement (Karmiloff-Smith and Inhelder, 1974, p. 208).

Procedures

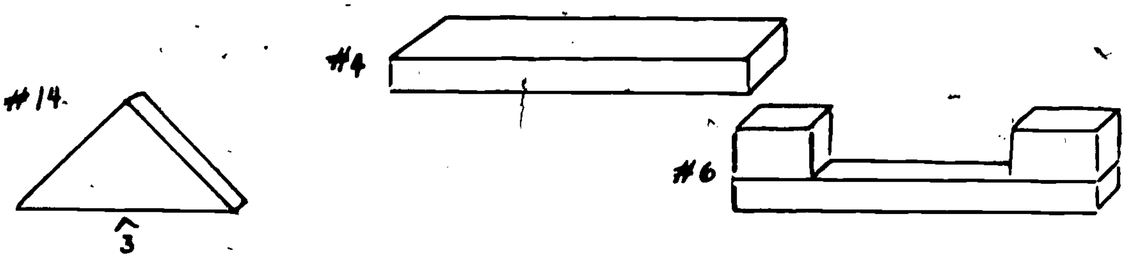
Subjects

A total of 128 children were recruited from the following schools: Worthington Preschool, Northampton Headstart, Skinner Laboratory School at the University of Massachusetts, Marks Meadow Elementary in Amherst, and the Russell H. Conwell Elementary in Worthington, Mass. Children were randomly assigned to one of four treatment conditions, equally balanced by sex and age. Thus there were eight boys and eight girls in each cell with two age groups, mean ages 4:9 (4:0-5:6) and 7:3 (6:6-8.0).

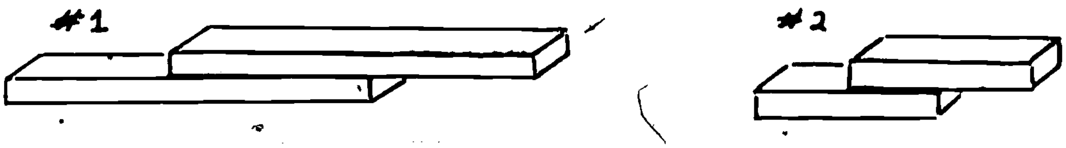
Materials

Training Task. Materials consisted of a 1/4 inch fulcrum raised along the length of a platform 6" x 10" and a series of blocks modified from the Karmiloff-Smith and Inhelder task:

Cluster #1: Length Blocks



Cluster #2: Displaced Base Blocks



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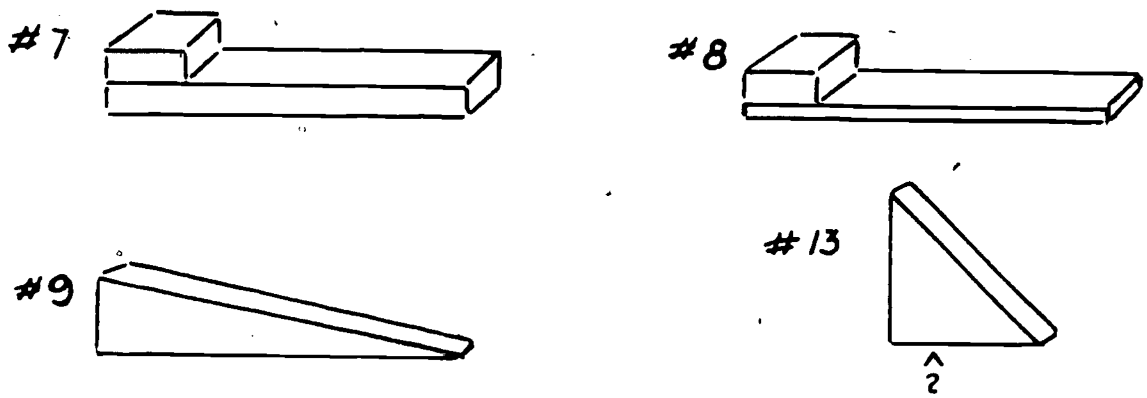
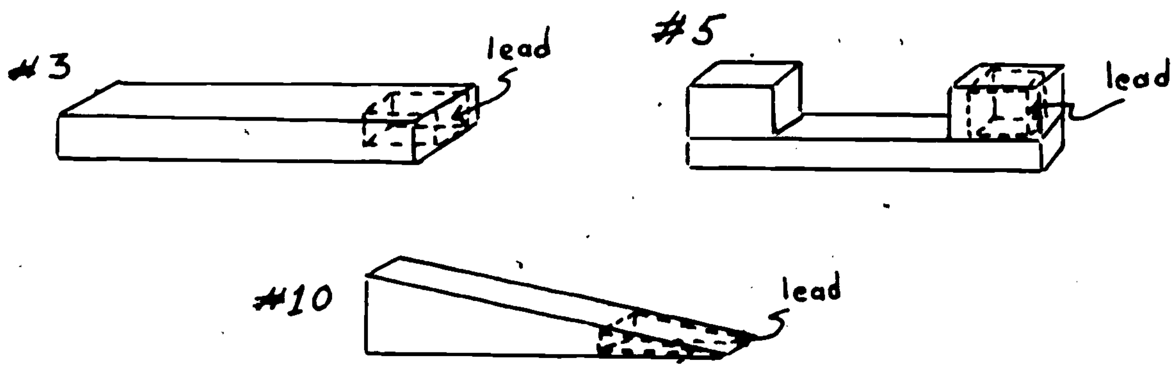
Cluster #3: Asymmetrical Unweighted Blocks



Cluster #4: Weighted Blocks



Cluster #5: Impossible Blocks

Figure 1: Training Task. Blocks drawn to a 1:6 scale. Drawings arranged into 5 conceptual clusters explained in text.

Blocks #9, 19, 13, 14, and 12 were not used by Karmiloff-Smith and Inhelder but were added to the task for the following reasons: #13 and #14 actually are the same block. On one plane the block can be balanced at the visual center (#14), however when the block is turned on its side (#13) it must be placed at point 2. Thus the child must take into account the fact that the weight distribution has changed and make adjustments. In other words the child must shift his/her placements away from the center for some edges but not others within the same block. This need to use two different strategies for the same block might heighten the child's awareness of weight distribution. Blocks #9 and #10, because they look identical, were added to contradict the child's area theory (the greater the visual area, the heavier the weight). Because the tip of block #10 has been weighted, the narrow half of the block is heavier than the wide half. Thus the child must place the block away from the wide half in order to successfully balance the block.

A group of "helper blocks" were also provided each subject to use as he/she wishes. All helper blocks were painted blue, to contrast with the blocks for balancing which were painted green. There were six blocks 2-3/4 x 2-3/4 x 1-7/8 inches, one block 1-3/8 x 1-3/8 x 1-7/8 inches, and two blocks 5-1/2 x 2-3/4 x 1-7/8 inches. Initially they placed them under the block for support; later they use them on top of the block to push the block down. These top placements are of interest in that they tell a great deal about the child's theory of balance. They are used to fill in space, for instance placed between the ends of blocks #5 and #6; or used to make the block symmetrical, placing a block at area 5 on blocks #7 or #8. The manner in which the "helpers" are used has been incorporated into our scoring system.

Transfer Task. A transfer task was also given consisting of two 2-3/4 x 2-3/4 x 1-7/8 inch blocks glued together, glued to a plywood base and spaced 8" from another identical stack also glued to the same base. A small doll was placed between the stacks and two 5-1/2 x 2-3/4 x 1-7/8 inches and four 2-3/4 x 2-3/4 x 1-7/8 inches unpainted blocks were provided. Subjects were asked to build a roof for the doll. Success at this task requires counter-weighting. (See figure 2)

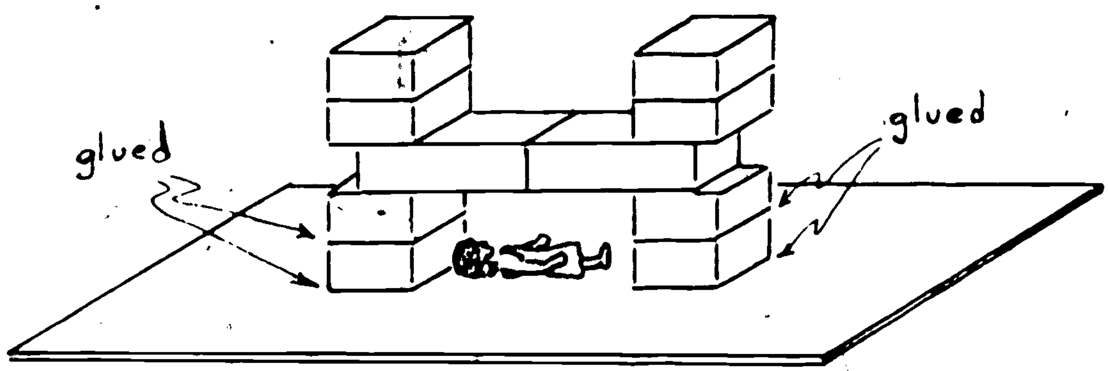


Figure 2: Transfer Task Cantilever roof, afford the only possible solution. Block drawn to a 1:6 scale.

Video equipment consisted of a Sony 365VT recorder and a CVM-112 video monitor. Childrens' responses were recorded with a Sony 3200 camera and a Sony microphone on a stand.

General Research Design

A basic factorial design of two age groups, sex, and four experimental conditions was used. Children were pretested on the transfer and training task in session one, later given four training sessions, followed by a post-test session on the training and transfer tasks. Briefly, in experimental condition one, called the Predict Object condition, the child was asked to predict what the block on the fulcrum, stopped in action on the video replay, will do when the tape is reactivated. In treatment 2, the Predict Self condition, the child was asked to predict, from looking at the replay of the block stopped in mid-air just before placement on the fulcrum, where the child him-herself is about to place the block. In treatment condition 3, called the Summarize Video condition, the child sees the entire footage from first grasp of the block to the end of the first clear release of the block and its subsequent balance or fall. The child in this condition is asked to summarize what he/she had just seen in the tape segment. In condition 4, called the Summarize No Video group the child is simply asked to summarize his/her most recent attempt to balance a block.

Task Presentation

All subjects met with the experimenter for four sessions. The time between session one and four ranged from 7 to 21 days with a mean of 14 days. Session one consisted of a pretest on the training task blocks with no video and the transfer task. Immediately thereafter the first of four training sessions began on the training task blocks. Sessions 2 and 3 consisted only of training; session 4 was training, then post test on the training and transfer tasks.

Pretest training task. The pretest was a free play period in which the child was given the opportunity to try each block in whatever order she/he choose. Blocks to be blaanced (green) were placed to the right of the child in the following spatial array:

#1	#3	#2
#4	#8	#9
#5	#7	#6
#13	#12	#10
	#11	

"Helper blocks" (blue) were placed to the left of the child. Video recorder and monitor were also placed to the child's right. The camera was placed 180 degrees from the child at the level of the fulcrum. The scope of the recording showed the child's face, hands, the fulcrum, and the action of the blocks. The monitor was covered during the pretest and post tests, as well as during all sessions in treatment condition four. The experimenter said, "I would like you to try to balance these blocks (points to green blocks), one at a time, on here (points to the fulcrum). These are helper blocks (points to blue blocks). You may use these to help if you like. You can begin with any of these that you wish (points again to green blocks)." After each block is tried the experimenter removed it and put it aside so that the child only tries each block once.

Transfer task pretest. After the child tried each of the blocks in training task pretest the experimenter placed the plywood base with the two glued stacks in front of the child with the other unpainted blocks randomly spread out behind the stacks. The experimenter says, "These are two walls (points to the stacks) and this woman lives in here (placing the doll between the stacks). But, one day it starts to rain. We don't want her to get all wet so I brought in these blocks (points to other unpainted blocks) so that you could build a roof for her." If the child builds a roof by adding more walls for support the experimenter asked, "Is there any way you can build a roof using only my walls?" When the child is satisfied with his/her attempts or says, "there is no way to do it", the experimenter removes the transfer task and begins the first of four training sessions.

Training session general directions. The experimenter designated the green blocks and said, "I would like you to balance these blocks one at a time on here (points to the fulcrum). These are the helper blocks which you may use to help you if you wish." Blocks are then presented to the child one at a time by the experimenter. In sessions one and three the blocks are presented in numerical order as indicated above, in sessions 2 and 4 the order is reversed. The remainder of the directions differ depending on the experimental condition and will therefore be discussed separately.

Predict Object Condition. The experimenter presented each block, one at a time, with hands on each side of the block so that the bottom length of the block is clear. She said, "Try this one." At the presentation of blocks, #2, 4, 5, 8, 10, 11, and 14 the experimenter pressed the counter on the video recorder to zero. After the completion of the episode (child attempts to balance the block and it balances or falls) with each of the fore-mentioned blocks, the experimenter rewinds tape to zero and said, "Let's look at you trying that block on television." The tape is then replayed until the point where the child places the block on the fulcrum. The experimenter stopped the action by pushing the recorder switch to pause and asked "What is the block going to do?" If the child did not respond, the experimenter probed with, "Will it balance or fall?" With a response of fall, the child was asked to show on the T.V. which direction. The experimenter recorded each prediction on the data sheets, then said to the child, "Let's see". The switch was then pushed to play and the remainder of the episode was replayed for the child to observe the correctness of the prediction. Blocks #1, 3, 6, 7, 9, 12, and 13 are presented to the child for balancing but no video replay was given.

Predict Self. The same beginning directions were given as above, however, during the replay, stop action occurred just before the child placed the block on the fulcrum. The child was asked to predict the placement of the block. The experimenter said, "Show me where on the block you are going to place it." If the child does not understand the question, the experimenter may say, "here, or here, or here?" while moving her finger across the bottom of the block from area one to five. Predictions are again recorded. Experimenter says, "Let's see." And the remainder of the episode is replayed.

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Summarize Video. Directions were the same as in the above conditions except that the tape is rewound to zero in the designated episodes and replayed to the child without stop action. Experimenter then said, "Tell me what happened". Responses are recorded on paper.

No Video. The child was presented each block to balance as in the other conditions. After the designated episodes, the child was simply asked, "Tell me what happened" and responses were recorded on paper.

Thus in all conditions subjects were questioned on seven episodes during a session. The length of each episode was the same across conditions since the replay began with the presentation of the block and ended when the child finished with the block. See figure 2.

Predict Object

tape stopped when block is on fulcrum

tape → /______________________/ /______________/

action → /____________________________________/

Predict Self

tape stopped before block is on fulcrum

tape → /__________/ /_________________________/

action → /____________________________________/

Summarize Video

tape stopped after block falls or balances

tape → /____________________________________/

action → /____________________________________/

Summarize No Video

no tape - child asked to summarize episode

action → /____________________________________/

Figure 2

Presentation order of the blocks was determined by first pairing the blocks according to visual similarities. Through piloting, blocks were then assigned a difficulty level and order was purposely varied so that the easiest or hardest block was not always presented first. The seven blocks used for questioning were chosen randomly although difficulty level was mixed. Thus three easy blocks were chosen and four difficult ones, #2, 4, 5, 8, 10, 11, 14. The presentation order in sessions 1 and 3 were reversed in sessions 2 and 4 to control for children learning a sequence of correct placements rather than a general understanding of balance. See figure 3.

Order	Block	Difficulty	Query
1.	#1	more	no
2.	#2	less	yes
3.	#7	less	no
4.	#8	more	yes
5.	#9	less	no
6.	#10	more	yes
7.	#3	more	no
8.	#4	less	yes
9.	#11	more	yes
10.	#12	less	no
11.	#13	more	no
12.	#14	less	yes
13.	#5	more	yes
14.	#6	less	no

Figure 3

Post Test Directions. The directions for posttests were the same as for the pretests on both the training task and the transfer task. The posttest transfer task was the exit task for all children.

Scoring

Training task. Two experimenters viewed the video tapes of the pretest on the training task (balancing blocks on the fulcrum). The two experimenters used a set of shorthand symbols to notate the position at which the child placed a block on the fulcrum and subsequent adjustments away from or toward the visual center of the block's base as well as rotations and the use of helper blocks. After each child's video tape was transcribed into this written notation then the experimenters assigned the child to one of five developmental levels. Since there were 14 different blocks this final score for each child was based on a specified "profile" of performance across all 14 blocks.

First we will describe the general definition of each level and then we will specify the profile of performance used as the criterion for a child receiving that score. Level 0 children would place the blocks on the fulcrum anywhere along their base. Adjustments were seldom made. Rotations occurred, but more as an exploration of the blocks and not as a search for a better means to balance the block on the fulcrum. At Level 1 children would place the blocks specifically on it's base and made adjustments toward the visual center of the lower most block, but not in reference to the entire glued together group of blocks. Thus on blocks 1, 2, 11, and 12 (see Figure 1) the child would place the block at the visual center of the lower block but not at the bisection of the entire glued-together structure between the two outer most ends. At Level 2 the child would place the block at the visual center of the two outer most ends. Thus on blocks 1 and 2 this means the child made placements slightly to the right of the position used by children in Level 1. Wé have termed the Level 1 strategy the VCB strategy (visual center of the base block only) and the Level 2 strategy the VC strategy (visual center of the entire block structure). At Level 3 children adjusted the block's position on the fulcrum until the block had half its area on the left of the fulcrum and half of its area on the right. Thus for blocks 9 and 10 the child placed the block somewhat to the left of the visual center of the baseline. At Level 4 children placed the block according to its center of gravity, irrespective of any of the three geometric (visual) equivalences characteristic of Levels 1, 2, and 3. Thus these children would place block 9 to the left of the visual center and block 10 (with hidden weight on the right) to the right of the visual center. We termed the Level 3 strategy the Area Center (AC) strategy and Level 4 the Weight Center (WC) strategy.

Since the individual blocks can be balanced successfully by a child holding a wrong theory we assigned levels according to the entire profile of all 14 blocks. We first determined what would be the perfect response profile across blocks if an idealized child held just one theory across all 14 blocks. For example, if a child held the theory that the block structure balanced when placed at the visual center of the base block (VCB, Level 1) this child would place blocks 13, 4, 6, 7, 8, 9, 13, 3, 5, and 10 at a point that bisected the end-to-end distance, but on blocks 1, 2, 11, and 12 would bisect only the linear distance of the two ends of the base block.

For Level 2 the child would make the same placements as the Level 1 child on blocks 13, 4, 6, 7, 8, 9, 13, 3, 5 and 10 while for blocks 1, 2, 11, and 12 the child would try to balance the blocks at the point that bisects the entire structure between the two outer most ends. For Level 3, the Area Center, the child would place blocks 14, 4, 6, 1, 2, 3, 5, 11, and 12 in the same manner as would the Level 2 child, but on blocks 7, 8, 9, 13, and 10 (all asymmetrical blocks) the child would adjust the placement to the left of the bisection of the outer most ends (see Figure 1). For Level 4, the Weight Center theory, children would place blocks 3, 5, and 10 to the right of their bisected center between the two outer most ends, place counterweights on blocks 11 and 12, while placing all other blocks in the same manner performed by Level 3 children.

Once this idealized profile had been defined for each developmental level, the two experimenters assigned each child to one of the 5 levels based on the rule of best fit. Since there were cases where children did not exhibit a perfect fit to any one of the 5 idealized profiles the experimenters double coded 20% of all video tapes to check interrater reliability. This yielded a reliability score of 84% based on the number of perfect matches divided by the number of subjects double coded. The particular subjects chosen for double coding came equally from both age groups, all four conditions, and both sexes.

In order to establish this developmental scale as a set of discrete, ordinal levels two statistics were performed. A Pearson product moment correlation between Age in months and Level was computed. This yielded a correlation of .62, significant at the .001 level. A Bonferrori t test yielded significant differences between Levels 0 & 1, 1 & 2, 2 & 3, while the difference between Levels 3 & 4 was not possible to compute given that only one child scored at Level 4 on the pre-test. These data lead us to conclude that the 5 point scale was both ordinally arranged and that each level designated psychologically distinct stages of development.

For purposes that will be made clear later, we also gave each child a score according to the number of blocks, out of 14, that he/she balanced successfully. This is called the Block Success score. The Pearson product moment correlation of this score with Age in months was .63. This score is to be distinguished from a similar score called the Cluster Success score. As one can see in Figure 1 the blocks have been conceptually grouped into five clusters. Cluster 1 is the Length Blocks, blocks that are symmetrical, have their bottom edge the same as the distance between the two outer most ends, and are not weighted internally with lead. Cluster 2 is the Displaced Base Blocks, blocks that share all the attributes of Cluster 1 except that the edge of the base block does not correspond to the total distance between the two outer most ends of the whole structure. Cluster 3 are the Asymmetrical Unweighted blocks, Cluster 4 the blocks with Hidden Weights and Cluster 5 are the Impossible Blocks, since they can not be balanced without the use of the helper blocks.

Each child was given a Cluster Success score based on the number of clusters in which he/she successfully balanced all the blocks in that cluster. Thus a child with a score of 5 reached this stringent criterion on all 5 of the clusters as defined above. In order to allow us to treat these scores as ordinal data, that is, to assume a child who scored 3 passed the Length Blocks, the Displaced Blocks, and the Asymmetrical Unweighted blocks, a Guttman test of scalability was performed on the pretest training task. Testing for the pattern that children who succeed on Cluster 5, succeed on <u>all</u> lower numbered clusters, and that children who succeed on Cluster 4 succeed <u>only</u> on all lower numbered clusters, and so forth the Gutmann analysis yielded a coefficient of reproducibility of .9531 and coefficient of scalability of .8000. The Pearson correlation with Age in months was .57.

In summary, there were 3 dependent variables for the training task. The pretest and posttest difference for each child for 1) the 5 point ordinal scale of balance strategies, henceforth called the Balance Strategy scale, 2) the total number of blocks successfully balanced, the Blocks Success score, and 3) the number of clusters successfully balanced, the Cluster Success score.

<u>Transfer task</u>. The video tapes from the pretest for the cantilever roof task were extensively coded for each move, reallignment of blocks, use and position of counterweights, use and position of lintels, use of supports from underneath. From an analysis of 30 pretest transfer task video tapes an ordinal scale was constructed and correlated with age. The experimenters were blind to the treatment condition during the entire coding process and constructed the ordinal scale on the basis of the shorthand notations, thereby minimizing the influence of age clues that might bias the decision regarding the hypothetical level of the particular roof building strategy.

A four level ordinal scale was constructed. Level 1 children would try to build supports from underneath the roof pieces, such as building a pretend wall. These children were also fond of filling in the space between the two pedestals with an assortment of blocks as if the task was to make the blocks rise to the common level of the predestals without concern for a vacant space beneath. Level 1 children would also simply hold a long block in between the two pedestals, over the sleeping doll, in an apparent need to see the final configuration even though they had not the slightest idea how to make the roof self-supporting without support from underneath.

At Level 2 children begin to show some awareness of the conflict between pushing the overhang block so far inward that it falls versus opening a rain gap when it is pushed back to render support. Thus these children were at least experimenting with the limits of providing support via lateral displacements outward and closing the rain gap via lateral displacements inward. What these children did not do was to invent some sort of lintel structure that spanned both overhang blocks or even several layers of overhang blocks that were staircased inward toward each other. Nor did they invent counterweights.

At Level 3 children began to understand that the alternation between pushing the overhang block back for support and forward to close the gap was <u>necessarily</u> insufficient. These children began to use additional blocks above the overhang blocks rather than below the overhang blocks. They would do such things as place a lintel between the two ends of the facing overhang blocks or place an additional layer of overhang blocks pushed inward slightly more than the first layer of overhang blocks. What distinguishes these children from the next and final level was that their attention was always drawn to filling the gap with the second layer of blocks rather than using this second layer as counterweights.

At Level 4 children discovered the creative use of the second layer of blocks not as filling the rain gain, but as providing support to a block <u>underneath</u>! By placing the small block on the outside ends of the two overhang blocks the overhang blocks gain enough cantilevered support to be pushed together without collapsing in on the doll.

After the four levels were defined by analysis of 30 video taped pretests, all children were assigned to one of these four levels for the pretest transfer task. A total of 20% of all subjects, equally distributed across age, sex, and treatment condition, were doubled coded. Interrater reliability was 83%on the final assignment of level. This reliability came subsequently to a prior establishment of intercoder reliability of 87% on translating the video tapes into action schemes using a special shorthand system to notate each block choice, displacement, and block configuration.

In order to establish that this scale was both ordinal and a psychologically valid measure of transfer of training two statistics were performed on all of the pretest scores. A Pearson product moment correlation was performed between the transfer task 4 point scale and age in months. This correlation was .380 and thus accounted for only 14% of the variance. The scale does not have the construct validity of being related to age. Nor was the test significantly correlated with performance on the 5 point scale of training task, Pearson $r = .17$. Unfortunately we could not justify further analyses using the transfer task 4 point ordinal scale, although the extensive notations of problem solving strategies can certainly be used in the future either as a separate study or to invent a new scale that has greater construct and psychological validity.

RESULTS

Age by Treatment Condition

An analysis of variance was computed using the variables Age, Sex, and Treatment Condition in a 2 x 2 x 4 design. The dependent variables were the pretest and posttest difference on each of three scores: the Balance Strategy scale, the Blocks Success score and the Cluster Success score. For all three dependent variable there was a significant main effect for age, no main effects for sex or treatment condition, and no significant two-way interaction effects. Since the Treatment Condition by Age group interaction approached significance when Age was held as a covariant, we decided to look to the pretest scores themselves, rather than Age in months, as a means of establishing the ability level of the children.

All children who passed at least one cluster of blocks were assigned to the Theory category, called Theory because these children at least had a rule that worked for a sub-set of all blocks. All children who did not reach criterion on at least one cluster of blocks were assigned to the Ego category, called Ego because these children attended more to their desire to have each block balance rather than some objective approach to the blocks themselves. Even though this sorting occurred after the study had been completed, we felt that sorting children into ability groups based on the pretest scores was preferrable to using the more indirect index of age. We called this new sorting for ability the Pretest Ability Score.

Pretest Ability by Treatment Condition

For the total sample of 128 children the division was fairly even between those passing one or more clusters on the pretest and those who passed none. However, in order to equalize the mean age for each of the four treatment conditions, several subjects were eliminated from the final analysis of variance. These subjects were eliminated only because of their age and in no way because of their scores on the dependent variables based on the pretest/posttest difference. Table 1 below presents the mean age and the numer of subjects for each Pretest Ability group and Treatment Condition.

		Predict Block	Predict Self	Summarize Video	No Video
Ego	Mean Age (months)	60.5	57.6	59.4	57.2
Group	N	10	10	11	12
Theory	Mean Age (months)	78.5	82.6	78.6	81.3
Group	N	18	17	17	17

Table 1

Mean age and number of subjects per Pretest Ability Group.

An analysis of variance was performed on each of the three dependent variables: the 5-point ordinal scale on Balance Strategy, the Blocks Success score and the Cluster Success score. In each case the child received a score based on the difference between his/her pretest score and his/her posttest score. The following tables summarize these results.

Balance Strategy Score

Mean scores for pretest ability and treatment condition

	Predict Block	Predict Self	Summarize Video	No Video
Ego Group	.60	-.50	.45	.42
Theory Group	.67	.88	.76	.24

ANOVA

	F	Significance
Main Effects		
Ego/Theory Ability	4.339	.040
Treatment Condition	1.287	.283
Two-way Interaction Effect		
Ego/Theory x Condition	3.242	.025

Table 2

Analysis of variance for Balance Strategy score

Blocks Success score

Mean scores for pretest ability and treatment condition

	Predict Block	Predict Self	Summarize Video	No Video
Ego Group	1.50	.10	.82	1.17
Theory Group	1.94	3.76	1.71	.71

ANOVA

Main Effects	F	Significance
Ego/Theory Ability	4.327	.040
Treatment Condition	.686	.563
Two-way Interaction Effect		
Ego/Theory Effect x Condition	2.618	.055

Table 3

Analysis of variance for Blocks Success score

Cluster Success Score

	Predict Block	Predict Self	Summarize Video	No Video
Ego Group	.60	.40	.55	.50
Theory Group	.61	1.59	.47	.41

ANOVA

Main Effects	F	Significance
Ego/Theory Ability	1.286	.259
Treatment Condition	1.114	.347
Two-way Interaction Effect		
Ego/Theory Effect x Condition	1.775	.153

Table 4

Analysis of variance for Cluster Success score

The main statistics of interest for their relevance to the hypotheses of this study are the two-way interactions between Pretest Ability and Treatment Condition. As can been seen in Tables 2, 3, and 4 this statistic was significant for both the Balance Strategy score and the Blocks Success score, but not the Cluster Success score. These first two ANOVA's were submitted to a Bonferroni $\underline{t}$ test to discover which cells were significantly different from each other at the .05 level or better.

For the Balance Strategy score, the training effects showed equal improvements for all Treatment Conditions within the Ego category of children. For the Theory category, the Predict Self condition yielded more improvement than did the No Video condition. For the comparisons between the Ego category of children and the Theory category, the Predict Self condition facilitated performance significantly more for the Theory group while it diminished performance for the Ego category of children.

The Block Success score corroborated the findings cited above, with the addition of several other significant differences between cells. On this dependent variable, the pretest-posttest difference in the number of blocks successfully balance, it was apparent that the Predict Self condition lead to diminished performance for the Ego category of children compared to the three other conditions that Ego children received. It was also statistically true that the Theory group performed better in the Predict Self condition than they did in the No Video condition.

DISCUSSION

The data confirmed our hypothesis that video feedback works in different ways for children at different levels of development. For children who have already begun to think about a general means to balance, rather than what they themselves do in a specific instance, stopped action video improves performance if the stopped action orientates the child to where they are about to place the block. This was seen in the Theory category of children in the Predict Self condition. With this type of video feedback the children had to reflect on their placement strategies. Having to predict the placement strategy just prior to the continuation of the feedback tape, combined with the feedback of the consequent success or failure, helped to bring the whole episode into an integrated systems of means-end relations. In the Predict Block condition, the feedback for the Theory children did not improve performance, because reflection on the means by which the block either balanced or fell was not accentuated.

Children who approached the block balancing task without some idea of a general rule, the Ego category of children, did not profit from any of the video feedback conditions, and in fact did somewhat more poorly on the Predict Self condition than on the No Video condition. For these children the video feedback was interesting, sometimes distracting, but was not used as a source of information upon which to reflect and from which to improve their own last attempt. To help explain these conclusions we will turn to a more qualitative description of the two groups of children, the Ego group and the Theory group.

Ego children, while being younger than the Theory group, were also characteristically different in their approach to the Training Task. Upon inspection of their response protocols, these children were more often the children who made only brief adjustments with a block if it did not balance. They were more likely to attribute a failure to a "bad block" than to their own placement strategy. They were more often the child who explored the physical attributes of each block independent of how those attributes related to the balancing task. Children in the Theory group understood, at least in part, that there was some "trick" or some rule that could be applied to several blocks, if not all blocks, that could be discovered if one thought clearly about several blocks at a time. These children would make spontaneous comments about "Hey, this one is not like the other one." This was most prevalent when two blocks looked alike but were weighted differently. Thus it is reasonable to conclude that such children would look to the video tape as a means to help them discover the correct means to establish balance for a variety of blocks.

When video feedback accentuated the balance or fall of the block itself (Predict Block condition) the Theory category of children did no better than with the Summarize Video and the No Video condition. Evidently reflection on the success and failure of the block, without relating the means by which that success/failure occurred, has no positive effects for problem solving in these situations.

The hypothesis about the advantage of the Predict Block condition for the less advanced children was partially supported. The original hypothesis stated that less advanced children have difficulty reflecting on the block's action. They more commonly and more egocentrically reflect on their own rather global acts such as pressing firmly on a block or simply making a firm contact between block and fulcrum as if a block were an extension of the hand rather than an independent set of relations to the fulcrum. Thus attention to the block's action, via video feedback should reduce their egocentrism.

On the Balance Strategy score the Ego category of children did do better on the Predict Block feedback condition than on the Predict Self condition, but their improvement from the Predict Block condition was not statistically better than improvements on Summarize Video and No Video conditions. This leads us to conclude that instead of the Predict Block condition being facilitative, the Predict Self condition was debilitative. It was true that for the younger children the instructions to point to the place where you put the block on the beam yielded initial confusion. Children would often just point to the fulcrum as a general cite. The experimenter would have to specifically request that the child point to someplace along the base of the block. Perhaps the Predict Self condition involved a set of orienting, stop action pauses that were so foreign to the child's approach to the real blocks that the video tapes just became one more item to overload memory.

The partial support for our hypothesis about the better value of Predict Block over Predict Self for the younger (Ego) children comes from the realization that the Predict Block condition did not debilitate performance as did the Predict Self. In effect, the Predict Block feedback was more consonant to the ideas that the less advanced child has in mind at the time of placing the real blocks. Yet this advantage was not significantly greater than the general request to summarize a recent attempt, either with video replay (Summarize Video) or without video replay (No Video).

This study began with a distinction between success and understanding. In an attempt to sever the criterion of understanding from the child's verbal explanations, we have looked to the cross block success as a criterion. Given the range of ostensibly contradictory types of blocks, a child successful at balancing, say both symmetrical blocks with hidden weights and symmetrical blocks without hidden weights can be categorized as a child who understands a general rule. Such a child would also not be satisfied that something was "wrong" with a block, but rather would assume that each block could be balanced in some way. These children would place the impossible blocks at the very limit of the lowest block's inside corner. Even though they may not have discovered the use of the helper blocks to counter weight the impossible blocks, they nevertheless understood that their task was to equalize the weight to the right and left of the fulcrum.

In order to provide a measure of interconstruct validity to this definition of understanding we performed a Kendall Tau correlation among the three dependent variables. The correlation between the Balance Strategy and the Blocks Success score was .77, significant at the .001 level; for the Balance Strategy scale and the Cluster Success score the correlation was .65, significant at the .001 level; and for the Blocks Success score and the Cluster Success score the correlation was .86, significant at the .001 level. This means that children who were successful on the number of blocks balanced and the number of clusters passed engaged in strategies of adjustment that indicated that their success was not accidental. Recall that the 5 point scale for Balance Strategy measured an increase in the deliberate use of weight cues for placement. It is particularly interesting that the Balance Strategy scale correlated so highly with the Cluster Success score. The Cluster Success score was a well organized ordinal scale, as indicated by the Guttman analysis, and indicated that each new cluster passed by a child represented a rule that incorporated success on the clusters ranked at lower levels. The correlation between the Balance Strategy, a measure of block balancing process, and the Cluster Success score, a measure of rule generality, gives strong support to our use of the word understanding to characterize the higher levels of success, success that resulted from theory testing.

It was indeed unfortunate that the cantilever roof task did not yield a well organized scale. Our intention was to demonstrate the generalization of training to the cantilever transfer task, thereby giving further evidence that the video feedback did more than imporove the child's memory for a recent attempt, but rather increased reflective abstraction of general means-ends relations. We feel that the problem had more to do with our inability to reduce the rich protocols to a single score per child representative of his/her best (or most prevalent) approach to the cantilever roof task. This task occupied by well the majority of our coding time and reviews to increase reliability. It was obvious to us that children entered this task with wide differences in their understanding of how to solve the problem of a roof with no underneath supports.

There are several possibilities why this task failed to yield useful data. One, the scoring system did not capture the most prevalent stage of development. Two, the task was so unfamiliar to children that it did not correlate with age. This reason is likened to say, people of all ages trying to learn the hula-hoop. The number of years one has lived gives one no advantage if the task has no familiar components from which the older person has a greater chance of already knowing. Three, the training task itself may have confused the child, even though the training task pretest was given only once before the child was asked to solve the transfer task pretest. On the training task the children had blocks with hidden weights that could be balanced with an overhang that extended beyond the visual center of the base. The training task also included impossible blocks, blocks that required counterweighting. While this experience with the impossible blocks could have heightened the child's awareness for the need of counterweights, failure on these blocks, on the other hand, could have heightened the child's confusion about balancing "normal" blocks in the transfer task.

Given the brevity of experience on the pretest training task, we favor the first and second possibility cited above. If the second possibility is true there is little we can do to improve the usefulness of the transfer task within the context of this study. However, on the premise that the problem lies in our method of data reduction, we will return to the protocols for a second attempt to abstract a more representative score for each child. The richness of the self-regulated learning, however, may prompt us to use some measure of within-session progress rather than simply end-of-session level.

References

Allen, D.W. (Ed.) Micro-teaching: A description. Stanford: Stanford Univerity Press, 1967.

Amsterdam, B. and Greenberg, L.M. Self-conscious behavior in infants: A videotape study. Developmental Psychbiology, 1977, 10, 1-6.

Astor, N.A. Therapeutic use of videotape feedback with aggressive children. Unpublished dissertation, 1977, Columbia University.

Berger, M.M. (Ed.) Videotape techniques in psychiatric training and treatment (Revised edition). New York: Brunner/Mazel Publishers, 1978.

Bigelow, A.E. The development of self-recognition in young children. Unpublished dissertation, 1975, Simon Fraser University (Canada).

Bunker, L.K., Shearer, J.D., and Hall, E. Video-taped feedback and children's learning to flutter kick, Perceptual and Motor Skills, 1976, 43, 371-374.

Dowrick, P. and Reeburn, J. Video editing and medication to produce a therapeutic self-model. Journal of Consulting and Clinical Psychology, 1977, 45, 1156-1158.

Esveldt, K.C., Dawson, P.C., and Forness, S.R. Effect of videotape feedback on children's classroom behavior. Journal of Educational Research, 1974, 67, 453-456.

Goshko, R. A developmental program for the modification of self-selected behaviors with elementary school children. Unpublished dissertation, 1973, University of Massachusetts at Amherst.

Greelis, M. Media stimulation and exceptional children, Mental Retardation, 1974, 12, 30-31.

Henderson, R., Swanson, R. and Zimmerman, B. Training seriation responses in young children through televised modeling of hierarchically sequenced rule components. American Educational Research Journal, 1975, 12, 479-489.

Inhelder, B., Sinclair, J. and Bovet, M. Learning and the development of cognition. Cambridge: Harvard University Press, 1974.

Jovick, T.L. A comparison of the effects of modeled (via videotape) concrete and abstract strategies with those of practice on problem solving performance of 2nd, 7th, and 12th graders. Unpublished dissertation, 1976, St. Louis University.

Karmiloff-Smith, A. and Inhelder, B. If you want to get ahead, get a theory. Cognition, 1974, 3, 195-212.

Kohlberg, L. Education for justice: A modern statement of the Platonic view. In N. F. Sizer and T. R. Sizer (Eds.) Moral education, Five lectures. Cambridge: Harvard University Press (1970).

Kuhn, D. and Ho, V. The role of self-directed activity in cognitive development. In K. E. Sigel, R.M. Golinkoff, and D. Brodzinsky (Eds.), Piagetian theory and research: New directions and applications. New York: Erlbaum, 1981.

Miklich, D.R., Chica, T.L. and Danker-Brown, P. Behavior modification by self modeling with subject awareness. Journal of Behavior Therapy and Experimental Psychiatry, 1977, 8, 125-130.

Piaget, J. The grasp of consciousness: Action and concept in the young child. Cambridge: Harvard University Press, 1976.

Piaget, J. The development of thought: Equilibration of cognitive structures. New York: Viking Press, 1977.

Robinson, R.W. Student self-appraisal and its relationship to achievement and self concept in intermediate grades. Unpublished dissertation, 1974, University of Arizona.

Rovet, J.F. Can audio-visual media teach children mental skills, Paper presented to the American Educational Research Association annual meeting, San Francisco, April, 1976.

Salomon, G. Interaction of media, cognition, and learning. San Francisco: Jossey-Bass Publishers, 1979.

Selman, R.L. Stages of role-taking and moral judgment as guides to social interaction. In T. Lickona (Ed.) A handbook of moral development. New York: Holt, Rinehart & Winston, 1976.

Thomas, G.M. Using videotaped modeling to increase attending behavior. Elementary School Guidance and Counseling, 1974, 9, 35-40.

Trullinger, R.W. First grade students' response to a language concept presented by videotape. Language, Speech and Hearing Services in the Schools, 1976, 7, 203-235.